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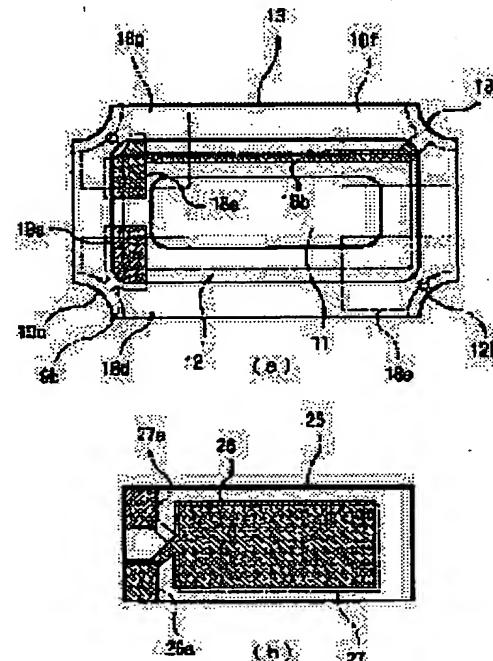
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## (54) PIEZOELECTRIC DEVICE

### (57)Abstract:

**PROBLEM TO BE SOLVED:** To provide a new piezoelectric device which does not affect the increase in sealing failure, the increase in wiring resistance and the operation characteristic of an internal piezoelectric body, even when a case body is miniaturized.

**SOLUTION:** A surface electrode 26 that is formed on the surface of a crystal vibrator piece 25 is provided with a connecting part 26a that is connected to an internal terminal part 19a, and a rear surface electrode 27 that is formed on the rear surface of the piece 25 is provided with a connecting part 27a that is connected to an internal terminal part 18a. Thus, a connection wiring 18b faces opposite the electrode 27, which is conductively connected to the wiring 18b, extended, and connected to an external terminal 18f. Thus, since the electrode 27 and the wiring 18b are maintained at almost the same potential to each other electrostatic capacity does not generate between the two, and the fluctuations in oscillation frequency is suppressed even if the distance between them fluctuates.



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CLAIMS

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[Claim(s)]

[Claim 1] While being the piezo-electric device characterized by providing the following and fixing said piezo electric crystal to the 1 side of said case object Said surface electrode and said rear-face electrode are connected to said connection wiring of a couple at said 1 side. Said one connection wiring A piezo-electric device connected conductively to said external terminal which passed through a location which counters self and an electrode mostly maintained at this potential although self was indirectly connected to an electrode or self connected conductively directly among said surface electrode or said rear-face electrode, and was prepared in a side besides the above A piezo electric crystal which has been arranged inside a case object and equipped with a surface electrode and a rear-face electrode An external terminal of a couple prepared in the side 1 of the exterior of said case object, and else Connection wiring of a couple which connects conductively respectively directly or indirectly between said surface electrode and said rear-face electrode, and said external terminals

[Claim 2] Claim 1 characterized by providing the following Said case object is the insulating member by which said connection wiring of a couple for making said external terminal of a couple connect this internal terminal area conductively to an internal terminal area of a couple for connecting conductively to said surface electrode and said rear-face electrode and a list directly or indirectly was formed on an inner surface while said external terminal of a couple was formed on an outside surface. A blockade member which holds and closes said piezo electric crystal by which the cantilevered suspension was carried out on an inner surface of this insulating member with additional coverage

[Claim 3] It is the piezo-electric device which is the insulating lid which said insulating member is the insulating frame joined on the insulating base or this insulating base in claim 2, and was joined on an insulating frame with which sequential cementation of said blockade member was carried out on said insulating member and a cover plate, or said insulating member.

[Claim 4] It is the piezo-electric device which said piezo electric crystal is a Xtal oscillating piece in any 1 term from claim 1 to claim 3, and constitutes a quartz resonator or a crystal oscillator.

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## DETAILED DESCRIPTION

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### [Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] This invention relates to a piezo-electric device, and relates to the suitable internal structure for the quartz resonator or crystal oscillator of a surface mount mold which has an external terminal on the outside surface of a case object especially.

[0002]

[Description of the Prior Art] Although the various piezo-electric devices which contained the piezo-electric oscillating piece in the package are marketed conventionally, such a piezo-electric device is briskly used for various electronic equipment. Especially, in the communication link field or the computer field, a piezo-electric device is an indispensable component part, and the quartz resonator, the crystal oscillator, etc. are built in all electronic equipment.

[0003] In recent years, in mobile communication equipment, such as small information machines and equipment, such as hard disk drive equipment, a mobile computer, and an IC card, or a cellular phone, a land mobile radiotelephone, and a paging system, expansion of the miniaturization of equipment and thin-shape-izing is remarkable, and the surface mount type device in which double-sided mounting is possible is increasingly required also of various piezo-electric devices, such as a piezoelectric transducer used for them, a piezo oscillator, and a SAW (surface acoustic wave) device, on the wiring circuit board.

[0004] The outline structure of the Xtal device which constitutes a quartz resonator or a crystal oscillator is shown in drawing 8 as an example of the above-mentioned piezo-electric device. This device is equipped with the case object 10 equipped with the cover plate 14 joined to the case main part of a three-tiered structure which consists of the insulating base 11 made from the ceramics, and insulating frames 12 and 13 which consist of allotropy material as shown in drawing 3 by the upper part of the insulating frame 13. In drawing 8 (a), it is drawing 8 (the plan of the Xtal oscillating piece 15 held in the interior of the case main part section is shown in (b.) about the plan of this case main part section. this case main part section process the insulating base 11 and insulating frames 12 and 13 into a ceramic powder , respectively in the state of the elastic non-harden sheet (green sheet ) a sheet added an additive and elaborated a sheet , and after carry out printing shaping of the conductive paste containing W (tungsten ) and form a metallized layer 6 by the predetermined pattern on those front faces , it constitute by carry out a laminating mutually and calcinate . After the case main part section of the configuration shown in drawing 3 is fabricated, on the above-mentioned metallized layer 6 exposed to the outside section of the case main part section, and the inner surface section, the laminating of the deposit 7 of nickel and Au is

carried out one by one, and connection wiring, an internal terminal area, an external terminal, etc. are formed by the predetermined pattern.

[0005] After being formed somewhat smaller than the building envelope of the insulating frame 13, forming the metallized layer 6 of a predetermined pattern in the upper surface of the insulating frame 12 and the building envelope of the insulating frame 12 carrying out the laminating of this insulating frame 12 to the insulating base 11 or the insulating frame 13, it forms the circuit patterns 18 and 19 shown with a graphic display slash by forming a deposit 7 with electrolysis plating on the front face of the exposed metallized layer. The internal terminal areas 18a and 19a of a couple are thickly formed in graphic display left-hand side among these circuit patterns 18 and 19. The connection wiring 18b and 19b is extended from the section terminal areas 18a and 19a among these. It is connected conductively to two external terminals 18d and 18f of the diagonal location formed on the base of the insulating base 11 through the outcrops 18c and 19c formed the graphic display upper right of the insulating frame 12, and on the corner front face of the two shape of a lower left cylinder inner surface.

[0006] The Xtal oscillating piece 15 shown in drawing 8 (b) is formed in the board configuration of a plane view rectangle, a surface electrode 16 is formed in the front-face side (graphic display near side) of vacuum evaporationo of Cr and Ag etc., and the rear-face electrode 17 (a graphic display dotted line shows) is similarly formed on the rear face. A surface electrode 16 is connected to inlet connection 16a formed on the surroundings lump and the rear face in the graphic display left end section from on the front face of the Xtal oscillating piece 15 at the rear-face side, and the rear-face electrode 17 is connected to inlet connection 17a which was extended in the graphic display left end section as it is, and was formed on the rear face. The Xtal oscillating piece 15 shown in drawing 8 (b) is arranged in the location shown with the alternate long and short dash line of drawing 8 (a) with a position as it is, it is joined to the internal terminal areas 18a and 19a, and the above-mentioned inlet connection 16a and 17a is fixed in the shape of a cantilever in the graphic display left end section.

[0007] In addition, it fills up with the flow object 5 which through hole 12b is a flow hole for making it flow through the conductive layer which consists of the metallized layer 6 and deposit 7 which were formed in the upper surface section of the external terminals 18e and 18g and the insulating frame 13 formed on the base of the insulating base 11, and becomes the interior from a conductive paste etc. in drawing 3 and drawing 8 </A>. The conductive layer on the insulating frame 13 connected conductively to the external terminals 18e and 18g by the flow object 5 is connected to a cover plate 14. The cover plate 14 is formed with the Fe-nickel-Co alloy (covar) etc. Therefore, a cover plate 14 flows for the external terminals 18e and 18g on the base of the insulating base 11.

[0008] In this quartz resonator, the surface electrode 16 of the Xtal oscillating piece 15 is connected to internal terminal area 18a, and internal terminal area 18a is connected conductively to 18f of external terminals on the base of the insulating base 11 through outcrop 18c through connection wiring 18b. Moreover, it connects with internal terminal area 19a, and the rear-face electrode 17 of the Xtal oscillating piece 15 is connected conductively to 18d of external terminals on the base of the insulating base 11 through connection wiring 19b and outcrop 19c.

[0009] Although the above-mentioned quartz resonator carries out the laminating of the two insulating frames 12 and 13 on the insulating base and it comes to join a cover plate 14 further, pattern printing of an internal terminal area, the connection wiring, etc. is carried out on the insulating base instead of the insulating frame 12, and there are some which are constituted on this insulating base as put the lid of a

core box. Furthermore, an integrated circuit chip is held in the interior of the above-mentioned case object, and there are some which are constituted as a crystal oscillator.

[0010]

[Problem(s) to be Solved by the Invention] However, in a piezo-electric device like the above-mentioned quartz resonator, if it is going to advance a miniaturization further, securing the engine performance, it is necessary to miniaturize a case object further, without seldom changing the size of a piezo electric crystal. However, if it is going to make a case object small, without changing the size of the Xtal oscillating piece 15 as shown in drawing 8 While there is a danger that will lap with the joint of the insulating base 11 where connection wiring 18b constitutes a case object, or the insulating frame 12, and poor closure of a case object will occur according to the shape of toothing by connection wiring 18b Since it will connect conductively only by the metallized layer 6 when it is going to form connection wiring 18b in the above-mentioned joint, the trouble that connection resistance will increase can be considered.

[0011] Moreover, although it is possible that the Xtal oscillating piece 15 brings connection wiring 18b close caudad for forming as it indicates drawing 5 (a) that long connection wiring 18b does not lap with a joint even if it miniaturizes a case object In this case, opposite arrangement of the connection wiring 18b connected to the surface electrode 16 is carried out at the rear-face electrode 17, and as shown in drawing 5 (b), electrostatic capacity Cs occurs between connection wiring 18b and the rear-face electrode 17. Since capacity value will be changed when the distance of connection wiring 18b and the rear-face electrode 17 changes if the Xtal oscillating piece 15 vibrates mechanically according to disturbance etc., this electrostatic capacity Cs can consider the trouble that this influences the oscillation frequency of the Xtal oscillating piece 15.

[0012] Furthermore, although also making it connect conductively to 18f of external terminals, without forming connection wiring 18b by preparing an internal terminal area in the edge of the Xtal oscillating piece 15 near 18f of external terminals is considered In this case, since the Xtal oscillating piece 15 will be supported not in the state of a cantilever but in the state of both \*\*\*\*\*, As the Xtal oscillating piece 15 is restrained, it becomes easy to affect the oscillation and it is shown in drawing 6 , since frequency change  $\Delta f$  [ as opposed to / compared with the Xtal oscillating piece A of a cantilever condition / temperature in the Xtal oscillating piece B of both the \*\*\*\*\* condition ] is large, the temperature characteristic of a quartz resonator or a crystal oscillator gets worse.

[0013] And although the method of connecting internal terminal area 18a to 18g of external terminals which approached most is also considered, the danger of connecting too hastily since the external terminals 18d and 18g formed at the short gap in this case turn into a terminal of reversed polarity is high, and a possibility that a problem will arise at the time of mounting becomes high.

[0014] Then, this invention solves the above-mentioned trouble and the technical problem is in offering the new piezo-electric device which does not affect the operating characteristic of poor closure, buildup of wiring resistance, or an internal piezo electric crystal even if it miniaturizes a case object.

[0015]

[Means for Solving the Problem] A means which this invention provided in order to solve the above-mentioned technical problem A piezo electric crystal which has been arranged inside a case object and equipped with a surface electrode and a rear-face electrode, An external terminal of a couple prepared in the side 1 of the exterior of said case object, and else, While being the piezo-electric device which has connection wiring of a couple which connects conductively respectively directly or indirectly

between said surface electrode and said rear-face electrode, and said external terminals and fixing said piezo electric crystal to the 1 side of said case object Said surface electrode and said rear-face electrode are connected to said connection wiring of a couple at said 1 side. Said one connection wiring It is the piezo-electric device connected conductively to said external terminal which passed through a location which counters self and an electrode mostly maintained at this potential although self was indirectly connected to an electrode or self connected conductively directly among said surface electrode or said rear-face electrode, and was prepared in a side besides the above.

[0016] According to this means, among a surface electrode formed in a piezo electric crystal in connection wiring which connects conductively an external terminal of the side 1 of a piezo electric crystal, and else, and a rear-face electrode, since it constituted so that it might pass through a location which counters the connection wiring concerned and an electrode mostly maintained at this potential Since electrostatic capacity between connection wiring and an electrode can be reduced and effect of an operation on the piezo electric crystal can be reduced even if it miniaturizes a case object and narrows a gap of connection wiring and a piezo electric crystal Even if it can prevent deterioration of the operating characteristic of a piezo electric crystal and miniaturizes a case object, poor closure of a case object and buildup of wiring resistance are also avoidable.

[0017] In addition, although various piezo electric crystals can be used as a piezo electric crystal, as a piezo-electric device, there are various devices using the property of a piezo electric crystal, and electrostatic capacity between connection wiring and an electrode can control fluctuation of oscillation frequency resulting from changing with both distance by applying the above-mentioned means to a piezoelectric transducer, a piezo oscillator, etc. especially. Moreover, the side 1 and else says an opposite side mutually. For example, if 1 side is right-hand side, the side else is left-hand side. Furthermore, a surface electrode and a rear-face electrode of a piezo electric crystal may not be directly connected conductively to an external terminal, for example, a piezo electric crystal will be connected to an oscillator circuit in a piezo oscillator, and a part of oscillator circuit will be connected to the above-mentioned external terminal. In this case, it is contained in this invention also when at least one of connection wiring from an electrode formed in a piezo electric crystal to an oscillator circuit and the connection wiring from an oscillator circuit to an external terminal has passed through the electrode concerned of a piezo electric crystal, and a location which counters.

[0018] While said external terminal of a couple is formed on an outside surface, said case object here An insulating member by which said connection wiring of a couple for making said external terminal of a couple connect this internal terminal area conductively to an internal terminal area of a couple for connecting conductively to said surface electrode and said rear-face electrode and a list directly or indirectly was formed on an inner surface, It is desirable to have a blockade member which holds and closes said piezo electric crystal by which the cantilevered suspension was carried out on an inner surface of this insulating member with additional coverage.

[0019] A manufacturing cost can also be reduced, while according to this means structure becomes easy and a miniaturization is also easy structure by forming an internal terminal area and connection wiring on a front face of an insulating member.

[0020] In this case, further, said insulating member may be the insulating frame joined on the insulating base or this insulating base, and said blockade member may be a cover plate which blocks an insulating frame and this insulating frame by which sequential cementation was carried out on said insulating

member, or the insulating lid joined on said insulating member.

[0021] In the above-mentioned means, said piezo electric crystal is a Xtal oscillating piece, it is desirable that it is the piezo-electric device which constitutes a quartz resonator or a crystal oscillator, in this case, it can miniaturize avoiding buildup of poor closure and wiring resistance, and fluctuation of oscillation frequency which moreover originates in a Xtal oscillating piece can be reduced.

[0022]

[Embodiment of the Invention] Next, the operation gestalt which starts this invention with reference to an accompanying drawing is explained. It is the outline perspective diagram in which drawing of longitudinal section and drawing 2 which show the cross section of the longitudinal direction of a quartz resonator whose drawing 1 is the piezo-electric device of this operation gestalt show the plan of the case main part section of this operation gestalt, and drawing 3 shows the structure of the case object of this operation gestalt. In addition, drawing 1 and drawing 3 have drawing-sized a part for the above-mentioned conventional example and the almost common structured division, and the explanation is omitted.

[0023] The surface electrode 26 formed on the front face of the Xtal oscillating piece 25 as this operation gestalt showed to drawing 2 (b) is equipped with inlet-connection 26a connected to internal terminal-area 19a shown in drawing 2 (a), and it differs from the conventional example at a point equipped with inlet-connection 27a by which the rear-face electrode 27 formed on the rear face of the Xtal oscillating piece 25 is connected to internal terminal-area 18a shown in drawing 2 (a). Therefore, a surface electrode 26 is connected conductively to 18d of external terminals through internal terminal area 19a, connection wiring 19b, and outcrop 19c, and the rear-face electrode 27 is connected conductively to 18f of external terminals through internal terminal area 18a, connection wiring 18b, and outcrop 18c.

[0024] With this operation gestalt, since the case main part section with graphic display vertical width of face smaller than the case main part section shown in drawing 8 (a) since the whole is miniaturized is adopted, connection wiring 18b passed through the location very near the Xtal oscillating piece 25, and although the rear-face electrode 27 and connection wiring 18b are slanting as shown in drawing 5 (a), it has countered. However, with this operation gestalt, since the rear-face electrode 27 is connected conductively to connection wiring 18b through internal terminal area 18a Since the rear-face electrode 27 and connection wiring 18b have this potential, they have almost no electrostatic capacity Cs shown by the dotted line in drawing 5 (b), and even if it changes the distance of the Xtal oscillating piece 25 and the case main part section (insulating frame 12) with the oscillation and acceleration which are received from the exterior, they hardly produce frequency change.

[0025] In addition, drawing 5 (b) shows the oscillator circuit which connects the quartz resonator containing the Xtal oscillating piece 25, a surface electrode 26, the rear-face electrode 27, the connection wiring 18b and 19b, and the external terminals 18d and 18f to the equal circuit containing resistance R1 and R2, an inverting circuit I, and electrostatic capacity Cg and Cd, and constitutes an oscillator. In this case, an integrated circuit may be built in the interior of a case object so that the oscillator circuit concerned may be constituted inside the case object of the above-mentioned operation gestalt. in this case, as connection wiring which counters the rear-face electrode 27 of the Xtal oscillating piece 25 even if it is connection wiring from a quartz resonator to an integrated circuit After connecting with an integrated circuit, you may be the connection wiring pulled out from Terminal P among the terminals S and P of an integrated circuit, and other rear-face electrodes and other wiring with which at least electric conduction is maintained mostly. In short If it is the rear-face electrode 27 and the connection wiring mostly

maintained at this potential, since electrostatic capacity will be reduced, the above-mentioned effect is acquired.

[0026] The data with which drawing 7 (a) measured with time 200 samples of frequency of the frequency rate of change at the time of designing a quartz resonator in the case size conventionally same with structure as this operation gestalt shown in drawing 8 in the condition attached in electronic equipment (conventionally henceforth structure only), and drawing 7 (b) show the data which measured with time 200 samples of frequency of the frequency rate of change in the structure of this operation gestalt shown in drawing 2.

[0027] As shown in these data, conventionally, the Xtal oscillating piece 15 vibrate according to the disturbance of the degree which be sensed for the body even if it apply neither an oscillation nor acceleration from the exterior, as shown in drawing 8 (a), especially in structure, change of frequency be observed in the range whose frequency rate of change be -15~+35 ppm, and occurrence frequency be high by within the limits especially whose frequency rate of change be -10~+10 ppm. On the other hand, in this operation gestalt, it has fallen within the range whose frequency rate of change is -2~+2 ppm altogether, and the stability of very good frequency is acquired.

[0028] In addition, although the laminating of the two insulating frames 12 and 13 is carried out on the insulating base 11 with the above-mentioned operation gestalt, you may be the case object of the structure which joined only the single insulating frame on the insulating base, and closed the up opening with the cover plate promptly. Moreover, although considered as the quartz resonator equipped only with the Xtal oscillating piece, as an alternate long and short dash line shows to drawing 1, the integrated circuit chip 20 connected to the Xtal oscillating piece may be made to build in, and a crystal oscillator may consist of above-mentioned operation gestalten. However, four external terminals 18d, 18e, 18f, and 18g turn into a control terminal, a supply potential terminal, a touch-down potential terminal (supply potential terminal), and an output terminal in this case.

[0029] On the insulating base 31 which consists of ceramics etc., as the dished insulating lid 32 (a graphic display two-dot chain line shows the plane of composition over the insulating base 31.) which consists of ceramics etc. is put, it joins, and the operation gestalt of another quartz resonator which held the Xtal oscillating piece 35 with the insulating base 31 and the insulating lid 32 is shown in drawing 4. In this operation gestalt, the external terminals 31a and 31b of a couple are formed in the both ends of the longitudinal direction on the base of the insulating base 31 of the deposit etc. And on the inner surface of the insulating base 31, internal terminal area 34a connected conductively through connection wiring 34b and outcrop 34c to external terminal 31a and internal terminal area 33a connected conductively through connection wiring 33b and outcrop 33c to external terminal 31b are formed.

[0030] The surface electrode 36 was formed on the front face of the Xtal oscillating piece 35 held in the interior, a surface electrode 36 is equipped with inlet connection 36a on the rear face of the end section of the Xtal oscillating piece 35, the rear-face electrode 37 was formed on the rear face of the Xtal oscillating piece 35, and the rear-face electrode 37 is equipped with inlet connection 37a on the rear face of the end section of the Xtal oscillating piece 35. And inlet connection 36a is joined to the above-mentioned internal terminal area 34a, and inlet connection 37a is joined to the above-mentioned internal terminal 33a.

[0031] Also in this operation gestalt, although the rear-face electrode 37 of the Xtal oscillating piece 35 and connection wiring 33b counter, both are connected conductively mutually, since it is this potential mostly, among both, electrostatic capacity is not generated but the frequency drift by the variation rate of

the Xtal oscillating piece 35 or deformation is reduced.

[0032] Although the example constituted from each operation gestalt explained above as the quartz resonator which used the Xtal oscillating piece, or a crystal oscillator was shown, it can be made to apply to the piezo-electric device using other raw materials by the same configuration. A piezo-electric sensor, an electrostrictive actuator, a SAW device, etc. can be considered other than the piezoelectric transducer using piezo electric crystals other than Xtal as an example of such a piezo-electric device, and a piezo oscillator.

[0033]

[Effect of the Invention] As explained above, according to this invention, the connection wiring which connects conductively the external terminal of the side 1 of a piezo electric crystal, and else Since it constituted so that it might pass through the location which counters the connection wiring concerned and the electrode mostly maintained at this potential among the surface electrode formed in the piezo electric crystal, and a rear-face electrode Since the electrostatic capacity between connection wiring and an electrode can be reduced and the effect of the operation on the piezo electric crystal can be reduced even if it miniaturizes a case object and narrows the gap of connection wiring and a piezo electric crystal Even if it can prevent deterioration of the operating characteristic of a piezo electric crystal and miniaturizes a case object, poor closure of a case object and buildup of wiring resistance are also avoidable.

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## DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] It is drawing of longitudinal section showing the cross section of the longitudinal direction of the quartz resonator as an operation gestalt of the piezo-electric device concerning this invention.

[Drawing 2] They are the plan (a) of the case main part section of this operation gestalt, and the plan (b) of a Xtal oscillating piece.

[Drawing 3] It is the outline perspective diagram showing the structure of the case object of this operation gestalt.

[Drawing 4] They are the plan (a) of the insulating base in the quartz resonator as another operation gestalt of the piezo-electric device concerning this invention, and the plan (b) of a Xtal oscillating piece.

[Drawing 5] They are drawing of longitudinal section (a) showing the cross section of the direction which intersects perpendicularly with the longitudinal direction in this operation gestalt, and the circuit diagram (b) of an oscillator circuit using the quartz resonator of this operation gestalt.

[Drawing 6] Frequency change to the temperature when supporting the frequency change (a) and the Xtal oscillating piece to the temperature when supporting a Xtal oscillating piece to a cantilever in a quartz resonator to both \*\*\*\* (it is the graph which shows (b).)

[Drawing 7] It is the graph (b) which shows the frequency of the frequency rate of change in the quartz resonator of the graph (a) which shows the frequency of the frequency rate of change in the quartz resonator of structure conventionally, and an operation gestalt.

[Drawing 8] They are the plan (a) of the case main part section of the quartz resonator of structure, and the plan (b) of a Xtal oscillating piece conventionally.

[Description of Notations]

10 Case Object

11 31 Insulating base

12 13 Insulating frame

14 Cover Plate

15, 25, 35 Xtal oscillating piece

16, 26, 36 Surface electrode

17, 27, 37 Rear-face electrode

18a, 19a, 33a, 34a Internal terminal area

18d, 18e, 18f, 18g External terminal

18b, 19b, 33b, 34b Connection wiring

**20 Integrated Circuit Chip**

**32 Insulating Lid**

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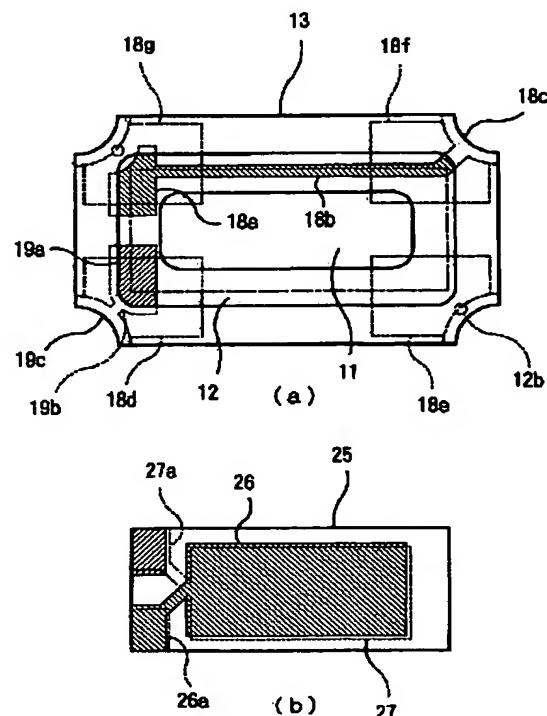
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(54)【発明の名称】 圧電デバイス

(57)【要約】

【課題】 ケース体を小型化しても封止不良や配線抵抗の増大或いは内部の圧電体の動作特性に影響を与えない新規の圧電デバイスを提供する。

【解決手段】 水晶振動片25の表面上に形成された表面電極26が内部端子部19aに接続される接続部26aを備え、水晶振動片25の裏面上に形成された裏面電極27が内部端子部18aに接続される接続部27aを備えていることにより、接続配線18bは、接続配線18bに導電接続されている裏面電極27に対向して延伸し、外部端子18fに接続される。したがって、裏面電極27と接続配線18bとは相互にほぼ同電位に保たれるため、両者間に静電容量が発生せず、両者間の距離が変動しても発振周波数の変動が抑制される。



(2)

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## 【特許請求の範囲】

【請求項1】 ケース体の内部に配置され、表面電極及び裏面電極を備えた圧電体と、前記ケース体の外部の一側及び他側に設けられた一対の外部端子と、前記表面電極及び前記裏面電極と前記外部端子との間をそれぞれ直接若しくは間接的に導電接続する一対の接続配線とを有する圧電デバイスであって、

前記ケース体の一側において前記圧電体が固定されるとともに、前記一側において前記表面電極及び前記裏面電極が一対の前記接続配線に接続され、一方の前記接続配線は、前記表面電極又は前記裏面電極のうち自身が直接に導電接続された電極若しくは自身に間接的に接続されているが自身とほぼ同電位に保たれた電極に対向する場所を通過して、前記他側に設けられた前記外部端子に導電接続されている圧電デバイス。

【請求項2】 請求項1において、前記ケース体は、外面上に一対の前記外部端子が形成されるとともに、内面上に、前記表面電極及び前記裏面電極に導電接続するための一対の内部端子部、並びに、該内部端子部を直接若しくは間接的に一対の前記外部端子に導電接続させるための一対の前記接続配線が形成された絶縁部材と、該絶縁部材の内面上に片持ち支持された前記圧電体を余裕を持って収容し封止する封鎖部材とを備えている圧電デバイス。

【請求項3】 請求項2において、前記絶縁部材は絶縁ベース若しくは該絶縁ベース上に接合された絶縁枠であり、前記封鎖部材は、前記絶縁部材上に順次接合された絶縁枠及び蓋板、又は、前記絶縁部材上に接合された絶縁蓋体である圧電デバイス。

【請求項4】 請求項1から請求項3までのいずれか1項において、前記圧電体は水晶振動片であり、水晶振動子若しくは水晶発振器を構成する圧電デバイス。

## 【発明の詳細な説明】

## 【0001】

【発明の属する技術分野】 本発明は圧電デバイスに係り、特に、ケース体の外面上に外部端子を有する表面実装型の水晶振動子又は水晶発振器に好適な内部構造に関する。

## 【0002】

【従来の技術】 従来、圧電振動片をパッケージに内蔵した種々の圧電デバイスが市販されているが、このような圧電デバイスは種々の電子機器に盛んに用いられている。特に通信分野や電算機分野においては圧電デバイスは必須の構成部品であり、水晶振動子、水晶発振器などはあらゆる電子機器に内蔵されている。

【0003】 近年、ハードディスクドライブ装置、モバイルコンピュータ、ICカードなどの小型の情報機器、或いは、携帯電話、自動車電話、ペーディングシステムなどの移動体通信機器においては、装置の小型化、薄型化的伸展が目覚ましく、それらに用いられる圧電振動子、

圧電発振器、SAW(弹性表面波)デバイスなどの各種圧電デバイスにも、配線回路基板上に両面実装が可能な表面実装タイプのデバイスが要求されるようになってきている。

【0004】 図8には、上記の圧電デバイスの一例として、水晶振動子又は水晶発振器を構成する水晶デバイスの概略構造を示す。このデバイスは、図3に示すようにセラミックス製の絶縁ベース11と、同素材からなる絶縁枠12、13とからなる3層構造のケース本体と、絶縁枠13の上部に接合される蓋板14とを備えたケース体10を備えている。図8(a)には、このケース本体部の平面図を、図8(b)にはケース本体部の内部に収容される水晶振動片15の平面図を示す。このケース本体部は、絶縁ベース11、絶縁枠12、13をそれぞれセラミックス粉末に添加剤を加えて練り上げた軟質の未硬化シート(グリーンシート)の状態でそれぞれ加工し、それらの表面上にW(タンクステン)を含む導電性ペーストを印刷成形してメタライズ層6を所定のパターンで形成した後、相互に積層して焼成することにより構成される。図3に示す形状のケース本体部が成形された後、ケース本体部の外面部及び内面部に露出した上記メタライズ層6の上にNiとAuのメッキ層7を順次積層して、接続配線、内部端子部及び外部端子などを所定のパターンで形成する。

【0005】 絶縁枠12の内部空間は、絶縁枠13の内部空間よりも一回り小さく形成されており、絶縁枠12の上面には所定パターンのメタライズ層6が形成され、この絶縁枠12を絶縁ベース11や絶縁枠13と積層させた後に、露出したメタライズ層の表面上に電解めっきによりメッキ層7を形成することによって、図示斜線で示す配線パターン18、19を形成する。これらの配線パターン18、19のうち、図示左側には一対の内部端子部18a、19aが肉厚に形成され、これらの内部端子部18a、19aから接続配線18b、19bが伸びて、絶縁枠12の図示右上と左下の二ヶ所の円筒内面状の角部表面上に形成された認出部18c、19cを経て、絶縁ベース11の底面上に形成された対角位置の二つの外部端子18d、18fに導電接続されている。

【0006】 図8(b)に示す水晶振動片15は平面視矩形の板形状に形成され、その表面側(図示手前側)には表面電極16がCr及びAgの蒸着などにより形成され、その裏面上には裏面電極17(図示点線で示す)が同様に形成されている。表面電極16は水晶振動片15の表面上から図示左端部にて裏面側に回り込み、裏面上に形成された接続部16aに接続され、裏面電極17はそのまま図示左端部に伸びて裏面上に形成された接続部17aに接続されている。図8(b)に示す水晶振動片15は、そのままの姿勢で図8(a)の一点鎖線で示す位置に配置され、上記接続部16a、17aが内部端子部18a、19aに接合され、図示左端部において片持

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ち梁状に固定される。

【0007】なお、図3及び図8においてスルーホール12bは絶縁ベース11の底面上に形成された外部端子18e及び18gと絶縁枠13の上面部に形成されたメタライズ層6及びメッキ層7からなる導電層とを導通させるための導通孔であり、内部に導電性ペーストなどからなる導通体5が充填される。導通体5によって外部端子18e, 18gに導電接続された絶縁枠13上の導電層は蓋板14に接続される。蓋板14はFe-Ni-Co合金(コバール)などにより形成されている。したがって、蓋板14は絶縁ベース11の底面上の外部端子18e, 18gに導通される。

【0008】この水晶振動子においては、水晶振動片15の表面電極16は内部端子部18aに接続され、内部端子部18aは接続配線18bを介し、露出部18cを経て絶縁ベース11の底面上の外部端子18fに導電接続されている。また、水晶振動片15の裏面電極17は内部端子部19aに接続され、接続配線19b及び露出部19cを経て絶縁ベース11の底面上の外部端子18dに導電接続されている。

【0009】上記の水晶振動子は絶縁ベース上に2つの絶縁枠12, 13を積層し、さらに蓋板14を接合してなるものであるが、絶縁枠12の代わりに絶縁ベース上に内部端子部や接続配線などをパターン印刷し、この絶縁ベース上に箱型の蓋体を被せるようにして構成されるものもある。さらに、上記のケース体の内部に集積回路チップを収容し、水晶発振器として構成されるものもある。

#### 【0010】

【発明が解決しようとする課題】ところが、上記の水晶振動子のような圧電デバイスにおいては、性能を確保しながらさらに小型化を進めようすると、圧電体の寸法を余り変えずにケース体をさらに小型化する必要がある。しかし、図8に示すように、水晶振動片15の寸法を変えずにケース体を小さくしようとすると、接続配線18bがケース体を構成する絶縁ベース11や絶縁枠12の接合部に重なり、接続配線18bによる凹凸形状によってケース体の封止不良が発生する危険性があるとともに、上記の接合部内に接続配線18bを形成しようとすると、メタライズ層6のみで導電接続することとなるため、接続抵抗が増大してしまうという問題点が考えられる。

【0011】また、ケース体を小型化しても長い接続配線18bが接合部に重ならないように形成するには図5(a)に示すように接続配線18bを水晶振動片15の下方に近づけることが考えられるが、この場合には、表面電極16に接続された接続配線18bが裏面電極17に対向配置され、図5(b)に示すように接続配線18bと裏面電極17との間に静電容量C<sub>s</sub>が発生する。この静電容量C<sub>s</sub>は、水晶振動片15が外乱などによって

機械的に振動すると、接続配線18bと裏面電極17との距離が変化することによって容量値が変動するため、これが水晶振動片15の振動周波数に影響するという問題点が考えられる。

【0012】さらに、外部端子18fに近い水晶振動片15の端部に内部端子部を設けることによって接続配線18bを形成せずに外部端子18fに導電接続させることも考えられるが、この場合には水晶振動片15を片持ちではなく両持ち状態で支持することとなるため、水晶振動片15を拘束してその振動に影響を与えやすくなり、図6に示すように片持ち状態の水晶振動片Aに較べて両持ち状態の水晶振動片Bは温度に対する周波数変化Δfが大きいことから、水晶振動子若しくは水晶発振器の温度特性が悪化する。

【0013】そして、内部端子部18aを最も近接した外部端子18gに接続するという方法も考えられるが、この場合には、短い間隔で形成された外部端子18dと18gとが逆極性の端子となるために短絡する危険性が高く、実装時に問題が生ずる可能性が高くなる。

【0014】そこで本発明は上記問題点を解決するものであり、その課題は、ケース体を小型化しても封止不良や配線抵抗の増大あるいは内部の圧電体の動作特性に影響を与えない新規の圧電デバイスを提供することにある。

#### 【0015】

【課題を解決するための手段】上記課題を解決するために本発明が講じた手段は、ケース体の内部に配置され、表面電極及び裏面電極を備えた圧電体と、前記ケース体の外部の一側及び他側に設けられた一対の外部端子と、前記表面電極及び前記裏面電極と前記外部端子との間をそれぞれ直接若しくは間接的に導電接続する一対の接続配線とを有する圧電デバイスであって、前記ケース体の一側において前記圧電体が固定されるとともに、前記一側において前記表面電極及び前記裏面電極が一対の前記接続配線に接続され、一方の前記接続配線は、前記表面電極又は前記裏面電極のうち自身が直接に導電接続された電極若しくは自身に間接的に接続されているが自身とほぼ同電位に保たれた電極に対向する場所を通過して、前記他側に設けられた前記外部端子に導電接続されている圧電デバイスである。

【0016】この手段によれば、圧電体の一側と、他側の外部端子とを導電接続する接続配線を、圧電体に形成された表面電極及び裏面電極のうち当該接続配線とほぼ同電位に保たれる電極に対向する場所を通過するように構成したので、ケース体を小型化して接続配線と圧電体との間隔を狭めても、接続配線と電極との間の静電容量を低減し、その圧電体の作用への影響を低減することができるので、圧電体の動作特性の劣化を防止することができ、また、ケース体を小型化してもケース体の封止不良や配線抵抗の増大を回避することもできる。

【0017】なお、圧電体としては種々の圧電体を用い

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ることができるが、圧電デバイスとしては、圧電体の特性を利用した種々のデバイスがあり、特に、圧電振動子や圧電発振器などに上記手段を適用することにより、接続配線と電極との間の静電容量が両者の距離によって変化することに起因する発振周波数の変動を抑制することができる。また、一側と他側とは相互に反対の側を言う。例えば、一側が右側であれば他側は左側である。さらに、圧電体の表面電極及び裏面電極は、直接に外部端子に導電接続されない場合もあり、たとえば、圧電発振器においては、圧電体は発振回路に接続され、発振回路の一部が上記外部端子に接続されることとなる。この場合、圧電体に形成された電極から発振回路までの接続配線と、発振回路から外部端子までの接続配線のうちの少なくとも一方が、圧電体の当該電極と対向する場所を通過している場合も本発明に含まれる。

【0018】ここで、前記ケース体は、外面上に一对の前記外部端子が形成されているとともに、内面上に、前記表面電極及び前記裏面電極に導電接続するための一対の内部端子部、並びに、該内部端子部を直接若しくは間接的に一对の前記外部端子に導電接続させるための一対の前記接続配線が形成された絶縁部材と、該絶縁部材の内面上に片持ち支持された前記圧電体を余裕を持って収容し封止する封鎖部材とを備えていることが好ましい。

【0019】この手段によれば、絶縁部材の表面上に内部端子部及び接続配線が形成されていることにより、構造が簡単になり小型化も容易であるとともに、製造コストも低減できる。

【0020】この場合にはさらに、前記絶縁部材は絶縁ベース若しくは該絶縁ベース上に接合された絶縁枠であり、前記封鎖部材は、前記絶縁部材上に順次接合された絶縁枠及び該絶縁枠を封鎖する蓋板、又は、前記絶縁部材上に接合された絶縁蓋体である場合がある。

【0021】上記手段においては、前記圧電体は水晶振動片であり、水晶振動子若しくは水晶発振器を構成する圧電デバイスであることが望ましく、この場合には、封止不良、配線抵抗の増大を回避しながら小型化が可能であり、しかも水晶振動片に起因する振動周波数の変動を低減することができる。

【0022】

【発明の実施の形態】次に、添付図面を参照して本発明に係る実施形態について説明する。図1は本実施形態の圧電デバイスである水晶振動子の長手方向の断面を示す縦断面図、図2は本実施形態のケース本体部の平面図、図3は本実施形態のケース体の構造を示す概略斜視図である。なお、図1及び図3は上記従来例とほぼ共通の構造部分を図面化しており、その説明は省略する。

【0023】この実施形態では、図2(b)に示すように、水晶振動片25の表面上に形成された表面電極26が図2(a)に示す内部端子部19aに接続される接続部26aを備え、水晶振動片25の裏面上に形成された

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裏面電極27が図2(a)に示す内部端子部18aに接続される接続部27aを備えている点で従来例と異なる。したがって、表面電極26は内部端子部19a、接続配線19b、露出部19cを経て外部端子18dに導電接続され、裏面電極27は内部端子部18a、接続配線18b、露出部18cを経て外部端子18fに導電接続されている。

【0024】この実施形態では、全体を小型化するために、図8(a)に示すケース本体部よりも図示上下幅の小さいケース本体部を採用しているため、接続配線18bが水晶振動片25に極めて近い場所を通過し、図5(a)に示すように、裏面電極27と接続配線18bとが斜めではあるが対向している。しかしながら、本実施形態では、裏面電極27は内部端子部18aを介して接続配線18bに導電接続されているので、裏面電極27と接続配線18bとは殆ど同電位となっているから、図5(b)に点線で示す静電容量C<sub>s</sub>を持たず、外部から受ける振動や加速度によって水晶振動片25とケース本体部(絶縁枠12)との距離が変動しても、周波数変化は殆ど生じない。

【0025】なお、図5(b)は水晶振動片25、表面電極26、裏面電極27、接続配線18b、19b、外部端子18d、18fを含む水晶振動子を、抵抗R1、R2、反転回路I及び静電容量Cg、Cdを含む等価回路に接続して発振器を構成する発振回路を示すものである。この場合、上記実施形態のケース体の内部に当該発振回路を構成するようにケース体内部に集積回路を内蔵してもよい。この場合には、水晶振動片25の裏面電極27に対向する接続配線としては、水晶振動子から集積回路までの接続配線であっても、或いは、集積回路に接続された後、集積回路の端子S、Pのうち端子Pから引き出された接続配線、その他の裏面電極とほぼ導電位が保たれる他の配線であってもよく、要は、裏面電極27とほぼ同電位に保たれる接続配線であれば、静電容量が低減されるため、上記の効果が得られる。

【0026】図7(a)は、水晶振動子を電子機器内に取り付けた状態で図8に示す従来構造にて本実施形態と同様のケース寸法に設計した場合(以下、単に従来構造という。)における周波数変化率の頻度を経時的に200サンプル測定したデータ、図7(b)は、図2に示す本実施形態の構造における周波数変化率の頻度を経時的に200サンプル測定したデータを示す。

【0027】これらのデータに示すように、従来構造においては、特に外部から振動や加速度を加えなくても身体に感じない程度の外乱により水晶振動片15が振動し、図8(a)に示すように周波数変化率が-15~+35ppmの範囲において周波数の変化が観測され、特に周波数変化率が-10~+10ppmの範囲内で発生頻度が高くなっている。これに対して、本実施形態においては、周波数変化率が-2~+2ppmの範囲内に全

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て収まっている、きわめて良好な周波数の安定性が得られている。

【0028】なお、上記実施形態では、絶縁ベース11の上に2つの絶縁枠12、13を積層しているが、絶縁ベース上に单一の絶縁枠のみを接合し、その上部開口を直ちに蓋板で封止した構造のケース体であってもよい。また、上記実施形態では、水晶振動片のみを備えた水晶振動子としているが、図1に一点鎖線で示すように、水晶振動片に接続された集積回路チップ20を内蔵させ、水晶発振器を構成してもよい。ただし、この場合には、4つの外部端子18d、18e、18f、18gは、制御端子、供給電位端子、接地電位端子（供給電位端子）及び出力端子となる。

【0029】図4には、セラミックスなどからなる絶縁ベース31上に、セラミックスなどからなる皿状の絶縁蓋体32（図示二点鎖線で絶縁ベース31に対する接合面を示す。）を被せるようにして接合し、絶縁ベース31と絶縁蓋体32によって水晶振動片35を収容した別の水晶振動子の実施形態を示す。この実施形態においては、絶縁ベース31の底面上の長手方向の両端部にメッキ層などにより一对の外部端子31a、31bが形成されている。そして、絶縁ベース31の内面上には、外部端子31aに対して接続配線34b及び露出部34cを介して導電接続された内部端子部34aと、外部端子31bに対して接続配線33b及び露出部33cを介して導電接続された内部端子部33aとが形成されている。

【0030】内部に収容される水晶振動片35の表面上には表面電極36が形成され、表面電極36は水晶振動片35の一端部の裏面上に接続部36aを備え、水晶振動片35の裏面上には裏面電極37が形成され、裏面電極37は水晶振動片35の一端部の裏面上に接続部37aを備えている。そして、接続部36aは上記内部端子部34aに接合され、接続部37aは上記内部端子33aに接合される。

【0031】この実施形態においても、水晶振動片35の裏面電極37と接続配線33bとが対向するが、両者は相互に導電接続されていてほぼ同電位であるため、両者間に静電容量は発生せず、水晶振動片35の変位や変形による周波数変動が低減される。

【0032】以上説明した各実施形態では、水晶振動片を用いた水晶振動子或いは水晶発振器として構成した例を示したが、同様の構成により、他の素材を用いた圧電デバイスに適用させることができる。このような圧電デバイスの例としては、水晶以外の圧電体を用いた圧電振動子、圧電発振器の他に、圧電センサ、圧電アクチュエータ、SAWデバイスなどが考えられる。

【0033】

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【発明の効果】以上説明したように本発明によれば、圧電体の一側と、他側の外部端子とを導電接続する接続配線を、圧電体に形成された表面電極及び裏面電極のうち当該接続配線とほぼ同電位に保たれる電極に対向する場所を通過するように構成したので、ケース体を小型化して接続配線と圧電体との間隔を狭めても、接続配線と電極との間の静電容量を低減してその圧電体の作用への影響を低減することができるので、圧電体の動作特性の劣化を防止することができ、また、ケース体を小型化してもケース体の封止不良や配線抵抗の増大を回避することができる。

#### 【図面の簡単な説明】

【図1】本発明に係る圧電デバイスの実施形態としての水晶振動子の長手方向の断面を示す縦断面図である。

【図2】同実施形態のケース本体部の平面図（a）及び水晶振動片の平面図（b）である。

【図3】同実施形態のケース体の構造を示す概略斜視図である。

【図4】本発明に係る圧電デバイスの別の実施形態としての水晶振動子における絶縁ベースの平面図（a）及び水晶振動片の平面図（b）である。

【図5】同実施形態における長手方向と直交する方向の断面を示す縦断面図（a）及び同実施形態の水晶振動子を用いた発振回路の回路図（b）である。

【図6】水晶振動子において水晶振動片を片持ちに支持したときの温度に対する周波数変化（a）及び水晶振動片を両持ちに支持したときの温度に対する周波数変化（b）を示すグラフである。

【図7】従来構造の水晶振動子における周波数変化率の頻度を示すグラフ（a）及び実施形態の水晶振動子における周波数変化率の頻度を示すグラフ（b）である。

【図8】従来構造の水晶振動子のケース本体部の平面図（a）及び水晶振動片の平面図（b）である。

#### 【符号の説明】

10 ケース体

11, 31 絶縁ベース

12, 13 絶縁枠

14 蓋板

15, 25, 35 水晶振動片

16, 26, 36 表面電極

17, 27, 37 裏面電極

18a, 19a, 33a, 34a 内部端子部

18d, 18e, 18f, 18g 外部端子

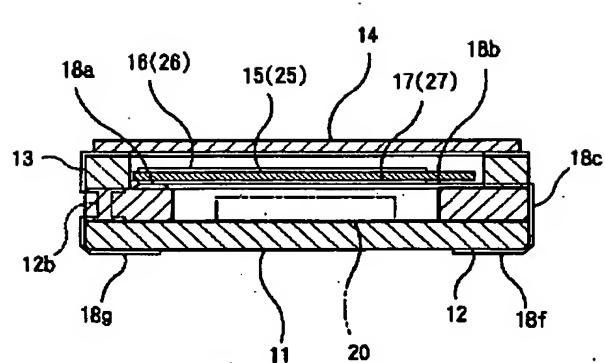
18b, 19b, 33b, 34b 接続配線

20 集積回路チップ

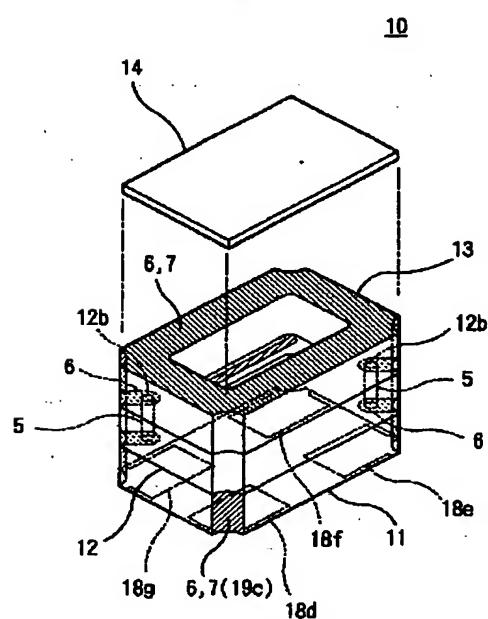
32 絶縁蓋体

(6)

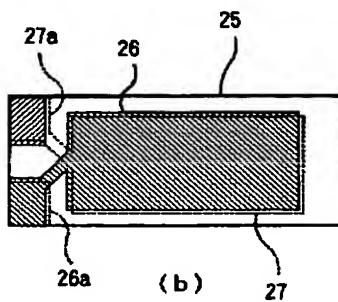
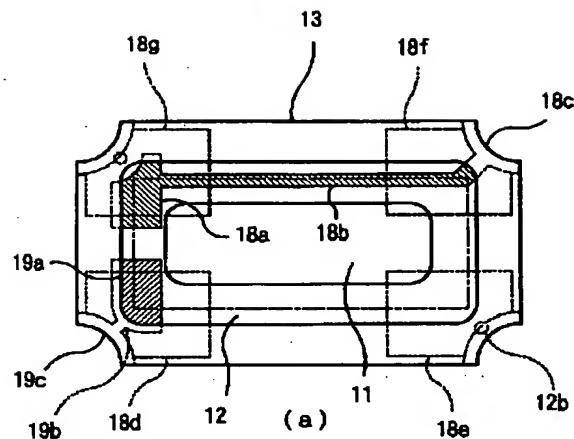
【図1】



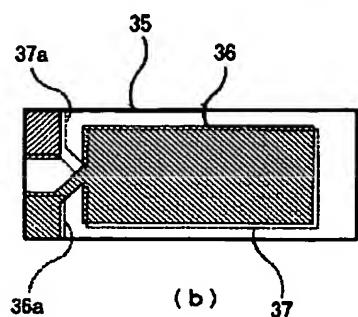
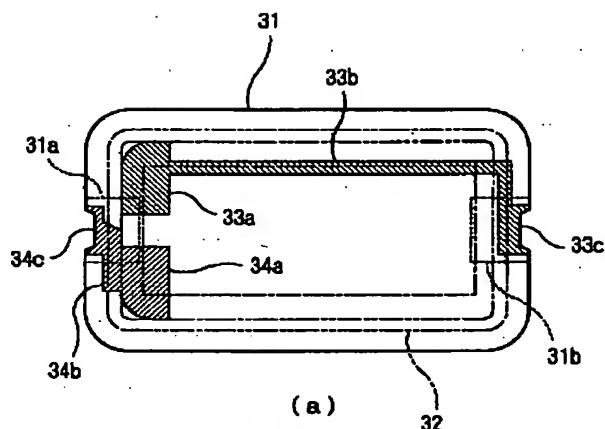
【図3】



【図2】

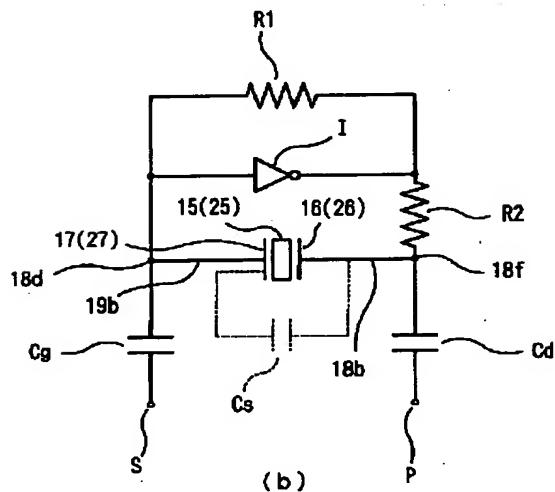
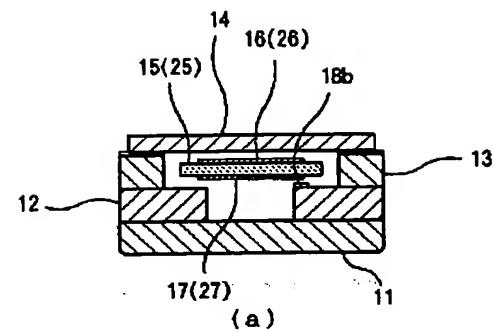


【図4】

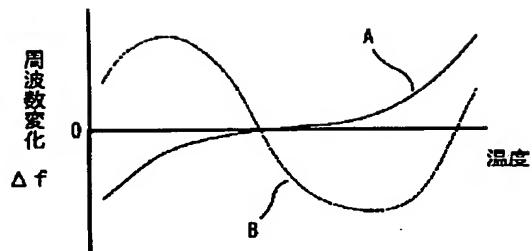


(7)

【図5】

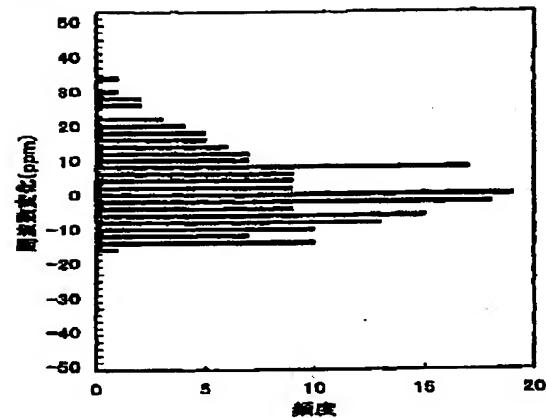


【図6】

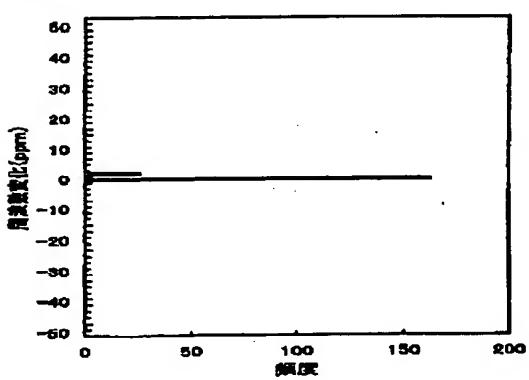


【図7】

(a)



(b)



(8)

【図8】

